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Research Article

Burden and Distribution of Malnutrition Among Children Aged 12–60 Months: A Cross-Sectional Analysis of Anthropometric Indicators and the Absence of Catch-Up Growth

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Abstract

Background: Child malnutrition remains a critical global public health challenge, with stunting, wasting, and underweight affecting millions of children and contributing to preventable morbidity, mortality, and long-term developmental consequences. Despite international efforts, progress toward achieving global nutrition targets remains insufficient, particularly in vulnerable populations. Understanding the burden and distribution of malnutrition across multiple anthropometric indicators is essential for designing effective, evidence-based interventions.

Objective: This study aimed to comprehensively characterize the burden and distribution of child malnutrition across multiple anthropometric indicators in children aged 12–60 months, examine age- and sex-specific patterns of nutritional deficits, and evaluate evidence for catch-up growth across childhood.

Methodology: A cross-sectional study was conducted on 330 children aged 12–60 months. Anthropometric measurements including height-for-age, weight-for-age, and mid-upper arm circumference (MUAC) were assessed and converted to percentile distributions. Data were stratified by age and sex, and statistical analyses including chi-square tests and trend analyses were performed to evaluate differences in malnutrition prevalence across demographic subgroups and to assess evidence of nutritional recovery with increasing age.

Results: Overall, 51.8% of children fell below the 5^{th} percentile for height-for-age (stunting), 41.5% for MUAC (wasting), and 24.2% for weight-for-age (underweight), with negligible representation in upper percentile categories. Height-for-age deficits were significantly more severe than weight-for-age and MUAC deficits (χ^2, $p < 0.001$). Male children demonstrated significantly higher burden of severe malnutrition across all indicators, particularly for stunting (106 males vs. 65 females below 5^{th} percentile; χ^2, $p < 0.05$). Age-stratified analysis revealed peak malnutrition prevalence at 12–24 months across all indicators, with the 24-month age group showing the highest burden of severe stunting (28.7% of all stunted children), underweight (27.5%), and wasting (16.1%). Despite significant variation in anthropometric distributions across age categories ($p < 0.001$), trend analyses revealed no statistically significant linear improvement with increasing age for any indicator (all $p > 0.05$), indicating absence of meaningful catch-up growth.

Conclusion: This study demonstrates a severe burden of both chronic and acute malnutrition among children aged 12–60 months, with stunting representing the predominant form of nutritional deficit. The absence of catch-up growth across age groups and the concentration of severe deficits during the critical 12–24 month period underscore the urgent need for early, sustained, and comprehensive nutritional interventions targeting the first 1000 days of life. Gender disparities, with males disproportionately affected, warrant further investigation and may necessitate sex-specific intervention strategies. Addressing this crisis requires integrated, multisectoral approaches encompassing nutrition-specific and nutrition-sensitive interventions to achieve sustainable improvements in child health and development.

Keywords: Child Malnutrition; Stunting; Wasting; Anthropometry; Catch-Up Growth

Introduction

Child malnutrition remains one of the most pressing global public health challenges, affecting millions of children under the age of five and contributing substantially to preventable morbidity and mortality worldwide. Despite decades of international commitment and significant progress in select regions, the burden of malnutrition persists at unacceptably high levels. According to the latest Joint Child Malnutrition Estimates released in 2025, approximately 150.2 million children under five years globally were stunted, 42.8 million were wasted, and 35.5 million were overweight in 2024, with Asia and Africa bearing the disproportionate share of this burden [1]. These figures underscore insufficient progress toward achieving the 2025 World Health Assembly global nutrition targets and the 2030 Sustainable Development Goal (SDG) target 2.2, which aims to end all forms of malnutrition [1]. Only 28% of all countries are currently on track to halve the number of children affected by stunting by 2030, while even fewer—just 17%—are expected to achieve the target of 3% prevalence for child overweight [1].

Malnutrition encompasses a spectrum of nutritional imbalances, including both undernutrition and overnutrition. Undernutrition manifests primarily as stunting [low height-for-age], wasting [low weight-for-height], and underweight (low weight-for-age), each reflecting distinct but often overlapping pathophysiological processes [2]. Stunting, the most prevalent form of child malnutrition globally, reflects chronic nutritional deprivation and serves as a marker of cumulative deficits in linear growth that typically begin in utero and accelerate during the first 1000 days of life [3]. Wasting, conversely, indicates acute malnutrition resulting from recent severe weight loss or failure to gain weight, often precipitated by acute illness or sudden food shortage. The co-occurrence of both chronic and acute malnutrition represents a particularly grave threat to child survival, development, and long-term health outcomes.

The consequences of childhood malnutrition extend far beyond immediate physical health, with profound implications for cognitive development, educational attainment, and economic productivity across the lifespan. Extensive evidence demonstrates that stunting during early childhood is associated with irreversible structural and functional brain impairments, including delayed myelination, reduced synaptic density, and diminished dendritic arborization, culminating in measurable cognitive deficits that persist into adulthood [4,5]. A recent meta-analysis encompassing studies from 1990 to 2025 revealed that childhood stunting is significantly associated with poorer performance across multiple cognitive sub-domains, including intelligence, executive function, visuospatial cognition, and socioemotional development, with effects more pronounced when confounding demographic, socioeconomic, parental, and health-related factors are controlled [5]. Longitudinal studies have further demonstrated that stunted children achieve approximately one year less schooling, experience higher rates of grade repetition, and exhibit reduced cognitive test scores in middle childhood and adolescence compared to their non-stunted peers [4,6]. These educational deficits translate into diminished economic productivity in adulthood, with stunted individuals earning lower wages and experiencing reduced lifetime income potential [4,6]. Among women, childhood stunting additionally compromises maternal reproductive health and increases the risk of adverse birth outcomes in the next generation, perpetuating an intergenerational cycle of undernutrition and poverty [4,6].

The critical window for nutritional intervention is now well established, with convergent evidence indicating that the first 1000 days—from conception through the child's second birthday—constitute the most sensitive period for both growth faltering and potential remediation [3]. Analysis of 33 longitudinal cohorts from low-and middle-income countries has demonstrated that conditions during preconception, pregnancy, and the first few months of life are crucial determinants of subsequent growth trajectories, with the majority of linear growth deficits accruing during the first 24 months [3]. Beyond this critical window, the capacity for catch-up growth diminishes substantially, and nutritional rehabilitation efforts yield progressively more limited returns. Moreover, linear growth deficits have been shown to continue accumulating even beyond the first 1000 days in many low- and middle-income settings, emphasizing both the persistence of adverse conditions and the limited spontaneous recovery in the absence of sustained intervention [7,8].

Accurate assessment of nutritional status is fundamental to effective screening, diagnosis, treatment allocation, and epidemiological surveillance. Anthropometric indicators—including height-for-age, weight-for-age, weight-for-height, and mid-upper arm circumference [MUAC]—serve as the cornerstone of malnutrition assessment in both clinical and community settings [2]. Each indicator captures distinct aspects of nutritional status and growth, with height-for-age reflecting long-term cumulative nutritional history, weight-for-height indicating current nutritional status and recent changes, and MUAC providing a simple, portable measure particularly useful for identifying acute malnutrition in resource-limited settings [9]. The World Health Organization recommends the use of both MUAC (<115 mm for severe acute malnutrition, <125 mm for moderate acute malnutrition) and weight-for-height z-scores (<-3 SD for severe wasting, -3 to -2 SD for moderate wasting) as complementary but independent diagnostic criteria for acute malnutrition in children aged 6–59 months [2]. However, growing evidence suggests that these two indicators identify partially overlapping but largely distinct populations of malnourished children, raising important questions about optimal screening and treatment algorithms [10,11].

Age and sex represent critical modifying factors in the epidemiology of child malnutrition, with distinct patterns emerging across different demographic subgroups. For the first time, the 2025 Joint Child Malnutrition Estimates presented sex-disaggregated data, revealing that boys are consistently more likely to be affected by stunting than girls across all regions globally [1]. This male predominance in malnutrition prevalence may reflect biological differences in growth velocity, metabolic requirements, and susceptibility to environmental stressors during critical developmental periods. However, the relationship between gender and malnutrition is complex and context-dependent, with sociocultural factors—including differential feeding practices, healthcare-seeking behaviours, and gender-based discrimination—potentially exerting substantial influence in certain settings [12]. Age-stratified analyses consistently demonstrate peak vulnerability during the 12–24 month period, coinciding with the transition from exclusive breastfeeding to complementary feeding and characterized by increased exposure to inadequate dietary diversity, insufficient energy density of family foods, suboptimal feeding practices, and heightened infectious disease burden [3].

The drivers of child malnutrition are multifactorial and operate across individual, household, community, and societal levels. Proximal determinants include inadequate maternal nutrition during pregnancy and lactation, suboptimal infant and young child feeding practices, recurrent infections (particularly diarrheal disease and respiratory infections), and micronutrient deficiencies. These proximate causes are themselves shaped by underlying determinants such as household food insecurity, poverty, lack of access to clean water and sanitation, inadequate healthcare infrastructure, low maternal education, and gender inequality. At the most distal level, structural factors including political instability, conflict, climate change, and economic policies create the conditions within which malnutrition flourishes. Recent evidence has underscored the critical importance of multisectoral approaches that simultaneously address nutritional, health, water and sanitation (WASH), agricultural, and social protection components to achieve meaningful and sustained reductions in child malnutrition [13].

Despite the well-documented burden and consequences of child malnutrition, significant knowledge gaps persist regarding population-specific patterns, risk factors, and intervention effectiveness in diverse contexts. Many studies have examined malnutrition prevalence in isolation, without comprehensive assessment across multiple anthropometric indicators or detailed age- and sex-stratified analysis. Furthermore, the relationship between different forms of malnutrition—particularly the concurrent burden of stunting and wasting—and the potential for recovery or catch-up growth across childhood remain incompletely characterized in many populations. Understanding these patterns is essential for designing targeted, evidence-based interventions and for allocating limited resources to the populations and age groups at greatest risk.

This study aims to comprehensively characterize the burden and distribution of child malnutrition across multiple anthropometric indicators (height-for-age, weight-for-age, and MUAC) in a population of children aged 12–60 months. Specifically, we seek to: (1) determine the prevalence and severity of stunting, underweight, and wasting across the study population; (2) examine age- and sex-specific patterns of nutritional deficits; (3) assess the concordance and discordance between different anthropometric indicators; (4) evaluate evidence for catch-up growth across age groups; and (5) identify high-risk subgroups that may benefit from targeted intervention. By providing detailed epidemiological characterization of malnutrition patterns in this vulnerable population, this study aims to inform evidence-based prevention and treatment strategies and contribute to the growing body of knowledge necessary to achieve the global nutrition targets and Sustainable Development Goals.

Methodology

A cross-sectional observational study was conducted in the Paediatric Outpatient Department (OPD) of Al-Nafees Medical College and Hospital over a six-month period (February 2021 to July 2021). Children aged 12–60 months presenting consecutively to the paediatric OPD during the study period were included.

Data were collected using a structured predesigned proforma, which recorded age, gender, height, weight, mid-upper arm circumference (MUAC), vaccination status, duration of breastfeeding, and age at weaning. Anthropometric measurements (height, weight, and MUAC) were obtained directly from each child at presentation by trained personnel using standardized techniques and calibrated instruments.

Completed forms were checked for completeness and data were entered into IBM SPSS version 26 for analysis. Nutritional status was assessed using height-for-age, weight-for-age, and MUAC percentiles. Categorical variables were summarized as frequencies and percentages. Chi-square tests were used to assess associations between anthropometric indicators and age or gender, and chi-square tests for trend were applied where appropriate. A p-value < 0.05 was considered statistically significant.

All data were anonymized prior to analysis, and measurements were non-invasive and performed as part of routine clinical assessment.

Results

The study included a total of 330 children aged 12–60 months. The gender distribution showed a modest but statistically significant male predominance, with 183 male children (55.5%) and 147 female children (44.5%) (χ^2, $p < 0.05$). This sex ratio imbalance is consistent with patterns observed in other nutritional surveys where male children may be overrepresented in healthcare-seeking populations.

The age-wise distribution of the cohort was non-uniform across the nine predefined age categories (12, 18, 24, 30, 36, 42, 48, 54, and 60 months) (Table-1). The largest concentration of children was observed at 24 months (n = 64, 19.4%), followed by 36 months (n = 50, 15.2%) and 18 months and 48 months (each n = 44, 13.3%). The smallest representation was at 54 months (n = 11, 3.3%).

Age in Months	Male	Female	Total
12	15	20	35
18	28	16	44
24	42	22	64
30	16	11	27
36	25	25	50
42	14	11	25
48	22	22	44
54	5	6	11
60	16	14	30
Total	183	147	330

Table 1: Distribution of Study Participants by Age and Gender (N = 330).

Statistical testing confirmed a significant deviation from a uniform age distribution (χ^2, $p < 0.001$), providing adequate representation of nutritionally vulnerable early childhood age groups and enabling meaningful age-stratified analyses.

When age was examined in relation to gender, male children numerically outnumbered females in most age categories, particularly at 18 months (28 males vs. 16 females), 24 months (42 males vs. 22 females), and 36 months (25 males vs. 25 females). Female representation was relatively higher at 12 months (20 females vs. 15 males), while other age groups showed relatively balanced distributions. The association between age group and gender was not statistically significant (χ^2, $p > 0.05$), indicating that male predominance was consistent across ages rather than age-specific.

Overall percentile-wise analysis demonstrated a pronounced clustering of children in the lower percentile categories across all three anthropometric indicators: height-for-age, weight-for-age, and mid-upper arm circumference (MUAC).

Height-for-age showed the greatest severity of nutritional deficit, with 171 children (51.8%) falling below the 5th percentile, representing the largest single subgroup and indicative of widespread chronic malnutrition or stunting. An additional 44 children (13.3%) fell below the 10th percentile, bringing the cumulative proportion below this threshold to 65.2%. The percentile distribution demonstrated progressive concentration in lower categories, with 49 children (14.8%) in the <25th percentile category, 34 children (10.3%) in the <50th percentile, and markedly reduced representation in upper percentile categories. Only 15 children (4.5%) were in the <75th percentile category, 6 children (1.8%) in the <90th percentile, 5 children (1.5%) in the <97th percentile, and 6 children (1.8%) above the 97th percentile. This distribution pattern, with minimal representation in upper percentiles and overwhelming concentration in the lowest categories, is characteristic of populations experiencing systematic nutritional deprivation.

Weight-for-age demonstrated a comparatively different but still concerning pattern. A total of 80 children (24.2%) fell below the 5th percentile, followed by 35 children (10.6%) below the 10th percentile, yielding a cumulative 34.8% below this threshold. The maximum concentration was observed in the <25th percentile category with 82 children (24.8%), while 68 children (20.6%) were in the <50th percentile category. Higher percentile categories showed progressively reduced representation: 34 children (10.3%) in <75th, 16 children (4.8%) in <90th, 4 children (1.2%) in <97th, and 11 children (3.3%) above the 97th percentile. While the burden of severe underweight (weight-for-age <5th percentile) was lower than that observed for stunting, the overall distribution remained heavily skewed toward lower percentiles, indicating ongoing nutritional inadequacy affecting weight gain.

MUAC percentile analysis revealed a substantial burden of acute malnutrition. A total of 137 children (41.5%) fell below the 5th percentile for MUAC, representing an intermediate severity between height-for-age and weight-for-age deficits. An additional 34 children (10.3%) fell below the 10th percentile, yielding 51.8% below this threshold. The distribution showed 76 children (23.0%) in the <25th percentile, 53 children (16.1%) in 50th percentile, and markedly reduced numbers in higher categories: 13 children (3.9%) in <75th, 9 children (2.7%) in <90th, 8 children (2.4%) in <97th percentile. Notably, no child in the entire cohort was recorded above the 97th percentile for MUAC, highlighting a globally depressed MUAC distribution and indicating widespread acute nutritional compromise.

Comparative analysis across anthropometric indicators demonstrated a statistically significant difference in severity distribution, with height-for-age deficits being significantly more pronounced than those observed for weight-for-age and MUAC (χ^2, $p < 0.001$). This pattern suggests that chronic nutritional deprivation, as reflected by stunting, represents the predominant form of malnutrition in this population, consistent with global trends showing stunting as the most prevalent form of child undernutrition.

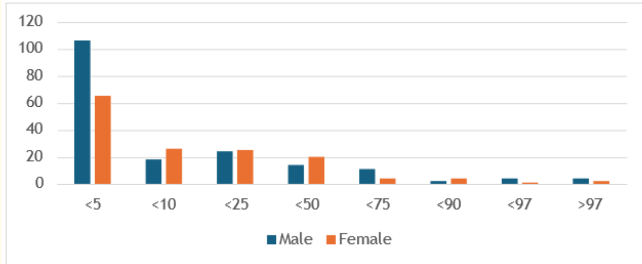

Figure 1: Height-for-Age Percentile Distribution by Gender Showing Male Predominance in Severe Stunting Categories.

Analysis of height-for-age percentiles by gender revealed a clear sex-based disparity. Among children below the 5th percentile for height, 106 were male and 65 were female, representing a male-to-female ratio of 1.63:1 and the maximum gender disparity observed across all percentile categories and indicators. Male children also predominated in the <10th percentile (18 males vs. 26 females) and <25th percentile categories (24 males vs. 25 females), though the gap narrowed in intermediate ranges. Females showed relatively higher representation in the <50th percentile (14 males vs. 20 females) and some higher categories. The minimum counts for both sexes were observed in the ≥97th percentile category (4 males vs. 2 females). The distribution of height-for-age percentiles differed significantly between males and females (χ^2, $p < 0.05$), consistent with recent global data showing boys are more likely to be affected by stunting than girls across all regions, as shown in Figure 1.

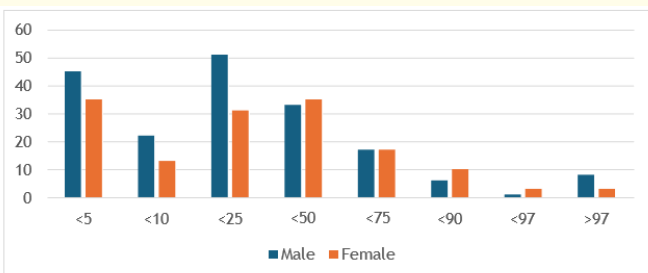

Figure 2: Weight-for-Age Percentile Distribution by Gender Demonstrating Sex-Based Disparities in Underweight Prevalence.

Weight-for-age analysis demonstrated similar but less pronounced gender disparities. Among children below the 5th percentile for weight, 45 were male and 35 were female, yielding a male-to-female ratio of 1.29:1. Males predominated in the lowest percentile categories (<5th and <10th: 22 males vs. 13 females), whereas females showed relatively higher representation in the <25th percentile (51 males vs. 31 females) and <50th percentile ranges (33 males vs. 35 females). The maximum concentration of children for both sexes was observed in the

<25th percentile category. Higher percentile categories showed more balanced distributions, with minimal representation observed in the ≥97th percentile category (8 males vs. 3 females). The distribution of weight-for-age percentiles differed significantly by gender (χ^2, $p < 0.05$), although the magnitude of this difference was smaller than that observed for height-for-age, suggesting that gender disparities are more pronounced for chronic malnutrition than for acute underweight, as shown in figure 2.

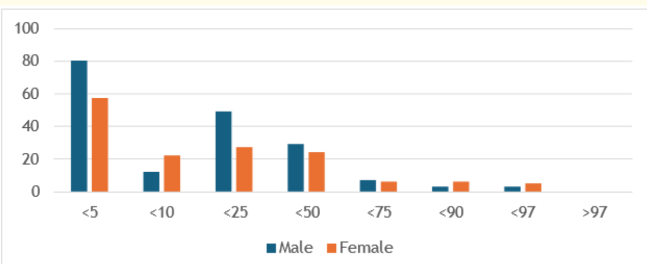

Figure 3: Mid-Upper Arm Circumference (MUAC) Percentile Distribution by Gender Revealing Acute Malnutrition Burden.

MUAC percentile analysis by gender showed that among children below the 5th percentile for MUAC, 80 were male and 57 were female, yielding a male-to-female ratio of 1.40:1. Males demonstrated higher absolute counts across all lower MUAC percentile categories (<5th, <25th), although females exceeded males in the <10th percentile category (12 males vs. 22 females) and showed comparable representation in intermediate categories (<50th: 29 males vs. 24 females). No child of either sex was recorded above the 97th percentile for MUAC, highlighting a universally depressed MUAC distribution across both genders. Overall, the association between MUAC percentile distribution and gender did not reach statistical significance (χ^2, $p > 0.05$), suggesting that while males showed higher absolute burden in severe categories, the overall distribution pattern was comparable between sexes for this indicator of acute malnutrition, as shown in figure 3.

Further age- and sex-stratified analysis of height-for-age demonstrated that male children aged 18–24 months constituted the largest subgroup within the <5th percentile category. Specifically, 15 males aged 18 months and 33 males aged 24 months were severely stunted, together representing 45.3% of all severely stunted males. Female children also demonstrated high burden of stunting in early age groups, with 7 females at 18 months and 16 females at 24 months in the <5th percentile, though with consistently lower absolute counts than males.

The age distribution of severe stunting (<5th percentile) across all children showed peak prevalence at 24 months (n = 49, 28.7% of all severely stunted children), followed by 18 months (n = 22, 12.9%) and 30 months (n = 20, 11.7%). Although the absolute number of severely stunted children showed some decline in older age groups (42 months: n = 13; 48 months: n = 18; 60 months: n = 16), low height-for-age percentiles persisted across all ages for both sexes, with no age group showing normalization of height-for-age distribution. Even at 60 months, 16 children remained below the 5th percentile, representing 53.3% of children in that age category. Statistical analysis confirmed significant variation in height-for-age distribution across age categories (χ^2, $p < 0.001$). However, trend analysis did not demonstrate a statistically significant monotonic improvement with increasing age ($p > 0.05$), suggesting a lack of meaningful catch-up growth and indicating sustained nutritional deprivation throughout early childhood.

Age-stratified analysis of weight-for-age revealed that severe underweight was most prevalent in children aged 12–24 months. Male children aged 18 and 24 months showed the highest representation in the <5th percentile category, with 8 males at 18 months and 15 males at 24 months severely underweight. Female children showed a more distributed pattern, with notable representation at 24 months (n = 7) and across multiple age groups.

The overall age distribution of severe underweight (<5th percentile) showed peak prevalence at 24 months (n= 22, 27.5% of all severely underweight children), followed by 12 months (n = 12, 15.0%) and 42 months (n = 10, 12.5%). With increasing age, there was a gradual redistribution toward higher percentiles, particularly evident in the <25th and <50th percentile categories at older ages. For instance, at 48 months, 19 children (43.2%) were in the <50th percentile category, compared to only 8 (18.2%) below the 5th percentile, indicating partial improvement relative to height-for-age patterns.

However, a substantial proportion of children remained below the 25th percentile even in older age groups: at 60 months, 6 children (20.0%) remained below the 5th percentile and 6 children (20.0%) were in the <25th percentile. Statistical testing confirmed significant variation in weight-for-age distribution across age categories (χ^2, $p < 0.05$), while trend analysis did not demonstrate a statistically significant linear improvement with age ($p > 0.05$), indicating persistent nutritional constraints despite some evidence of relative weight gain in older children.

When MUAC percentiles were examined across age groups and gender, severe deficits were most prominent in the 12-, 18-, and 24-month age groups. Among children below the 5th percentile for MUAC, male children at 18 months (n = 19) and 24 months (n = 18) contributed the largest share, together representing 46.3% of severely wasted males. Female children showed high burden at 12 months (n = 13), representing 22.8% of severely wasted females.

The overall age distribution of severe MUAC deficits (<5th percentile) showed peak prevalence at 24 months (n= 22, 16.1% of all children with MUAC <5th percentile), 18 months (n = 24, 17.5%), and 12 months (n = 20, 14.6%), confirming that the 12–24 month period represents the age of greatest vulnerability for acute malnutrition. Although older age groups showed some upward shift in MUAC percentiles, low MUAC values persisted even at 48–60 months. At 48 months, 20 children (45.5%) remained below the 5th percentile, and at 60 months, 14 children (46.7%) were below this threshold, indicating ongoing acute nutritional compromise beyond infancy.

Statistical analysis demonstrated significant variation in MUAC distribution across age categories (χ^2, $p < 0.001$). However, trend analysis failed to show a statistically significant linear improvement with increasing age ($p > 0.05$), consistent with findings for height-for-age and weight-for-age and reinforcing the interpretation that meaningful nutritional recovery is not occurring spontaneously across childhood in this population.

In comparative analysis across indicators, height-for-age emerged as the most severely and persistently affected anthropometric measure (51.8% below 5th percentile), followed by MUAC (41.5% below 5th percentile), with weight-for-age being comparatively less affected (24.2% below 5th percentile). This hierarchy of severity—stunting > wasting > underweight—is characteristic of populations experiencing chronic food insecurity and inadequate infant and young child feeding practices.

Across all analyses, younger children (12–24 months) consistently demonstrated the highest burden of nutritional deficits across all three anthropometric indicators. The 24-month age group showed peak prevalence for severe stunting (28.7% of all stunted children), severe underweight (27.5%), and severe wasting by MUAC (16.1%), confirming this critical window as the period of greatest nutritional vulnerability.

Male children exhibited higher absolute counts of severe malnutrition across all indicators, particularly for linear growth failure (height-for-age), with statistically significant gender differences observed for height-for-age ($p < 0.05$) and weight-for-age ($p < 0.05$), but not for MUAC ($p > 0.05$). This male predominance in stunting prevalence aligns with emerging global evidence showing consistent sex-based disparities in child malnutrition.

The absence of statistically significant linear trends toward improvement with increasing age across all three anthropometric indicators (all $p > 0.05$ for trend analyses), despite significant variation by age category, indicates limited evidence of nutritional recovery or catch-up growth across childhood. This finding suggests either sustained nutritional inadequacy throughout early childhood or that the critical window for effective catch-up growth has closed for many children in this cohort.

Collectively, these findings demonstrate a high burden of both chronic malnutrition (stunting) and acute malnutrition (wasting), marked age- and sex-related disparities, and limited evidence of spontaneous nutritional recovery across childhood, highlighting the urgent need for comprehensive, early, and sustained nutritional interventions targeting the first 1000 days of life.

Discussion

The present study reveals a substantial burden of both chronic and acute malnutrition among children aged 12–60 months, with pronounced deficits across all anthropometric indicators. The findings demonstrate that height-for-age emerged as the most severely affected measure, with over half of the study population (51.8%) falling below the 5th percentile, indicative of chronic undernutrition and stunting. This was followed by MUAC, with 41.5% below the 5th percentile, and weight-for-age, affecting 24.2% of children in the lowest percentile category. The clustering of children in lower percentile ranges across all indicators, combined with negligible representation in upper percentiles, underscores a systemic nutritional crisis affecting this vulnerable population. These findings align with global estimates indicating that insufficient progress has been made toward achieving the 2025 World Health Assembly targets and the 2030 Sustainable Development Goals for child malnutrition reduction [1].

The predominance of stunting (height-for-age deficits) over underweight (weight-for-age deficits) is consistent with patterns observed in settings characterized by chronic food insecurity and inadequate complementary feeding practices. Stunting reflects cumulative, long-term nutritional deprivation beginning in utero and extending through the critical first 1000 days of life [3]. The persistence of severe linear growth deficits across all age groups, without evidence of catch-up growth, suggests sustained exposure to adverse nutritional conditions rather than transient episodes of food shortage. This pattern is particularly concerning given that linear growth failure during early childhood is associated with irreversible cognitive deficits, reduced educational attainment, diminished economic productivity in adulthood, and intergenerational transmission of undernutrition [4]. Recent evidence demonstrates that stunted children exhibit impaired behavioural development, are less likely to enrol in school, and achieve lower academic grades compared to non-stunted peers [4].

The substantial burden of low MUAC percentiles (41.5% below the 5th percentile) indicates a concurrent prevalence of acute malnutrition, likely reflecting recent or ongoing episodes of wasting. The coexistence of high rates of both stunting and wasting suggests a dual burden of chronic and acute undernutrition, which has been increasingly recognized in resource-limited settings [14]. This concurrent affliction places children at particularly elevated risk of morbidity and mortality, as acute-on-chronic malnutrition compromises both structural development and immediate metabolic reserves necessary for immune function and recovery from illness. Globally, 42.8 million children under five years suffered from wasting in 2024, with South Asia bearing the highest prevalence [1].

Age-stratified analysis revealed that the highest burden of malnutrition occurred in the 12–24 month age range, coinciding with the critical period of complementary feeding and weaning. This age group represents a well-documented window of heightened nutritional vulnerability, during which children transition from exclusive breastfeeding to family foods. Inadequate dietary diversity, insufficient energy density of complementary foods, poor feeding practices, and increased infectious disease exposure during this period likely contribute to the observed peak in malnutrition [3]. Analysis of 33 longitudinal cohorts from low- and middle-income countries demonstrated that conditions during pre-conception, pregnancy, and the first few months of life are crucial determinants of growth faltering risk [3]. The persistence of nutritional deficits beyond 24 months, with no statistically significant linear improvement with age, suggests that early insults to growth are not spontaneously corrected and that nutritional inadequacy continues throughout early childhood.

The absence of meaningful catch-up growth, as evidenced by the lack of significant monotonic improvement in anthropometric indicators with increasing age, is particularly noteworthy. Catch-up growth typically occurs when nutritional conditions improve, allowing previously undernourished children to accelerate their growth trajectory toward genetic potential. The failure to observe such recovery in this cohort implies either sustained nutritional deprivation across all age groups or that the critical window for catch-up growth has been missed for many children [15]. A 1994 seminal review by Martorell and colleagues suggested that most malnourished children retain capacity for full catch-up growth [16,17], yet modern nutritional interventions in stunted child populations often lack relevant catch-up in height, suggesting that factors beyond nutrition alone may be implicated [17]. This finding has important programmatic implications, emphasizing the necessity of early intervention before 24 months of age and the potential limited efficacy of nutritional rehabilitation efforts initiated beyond this critical period. Evidence indicates that linear growth deficits continue to accumulate beyond the first 1000 days in low- and middle-income countries, further underscoring the urgency of early action [7,8].

Gender-based disparities were evident across all anthropometric indicators, with male children demonstrating higher absolute counts in the lowest percentile categories, particularly for height-for-age. This male predominance in severe malnutrition has been documented in various populations and may reflect biological differences in growth velocity, metabolic demands, and susceptibility to environmental stressors. The 2025 Joint Child Malnutrition Estimates presented sex-disaggregated data for the first time, confirming that boys are more likely to be affected by stunting than girls in all regions globally [1]. Males typically have higher nutritional requirements during periods of rapid growth and may be more vulnerable to growth faltering when these needs are unmet. Additionally, sex-differential feeding practices, healthcare-seeking behaviours, or disease susceptibility may contribute to observed disparities, though such behavioural factors were not directly assessed in the present study. However, the relationship between gender and malnutrition is complex and context-dependent; in some settings, particularly those with strong gender discrimination, girls face higher malnutrition risk due to preferential feeding of male children [12,18].

The utilization of MUAC as a diagnostic indicator warrants specific discussion. While MUAC is recommended by WHO for community-level screening due to its simplicity and portability, recent evidence highlights diagnostic discordance between MUAC and weight-for-height z-score (WHZ), with the two indicators identifying overlapping but not identical groups of wasted children [10,19]. Studies have demonstrated that MUAC and WHZ may miss 25–80% of each other's cases, suggesting that reliance on a single indicator may underestimate the true burden of acute malnutrition [10]. Current WHO cut-offs for MUAC (<115 mm for severe acute malnutrition, <125 mm for moderate acute malnutrition) have been shown to have relatively poor sensitivity, particularly when used as the sole screening criterion [11,20]. Age- and sex-specific MUAC thresholds may improve diagnostic accuracy and case identification, though implementation challenges remain [19,21]. The 2024 WHO guideline on prevention and management of wasting acknowledged these ongoing debates while reaffirming the use of both MUAC and WHZ for comprehensive assessment [2].

The complete absence of children above the 97th percentile for MUAC and the negligible representation in upper percentile categories for height and weight indicate a uniform depression of growth parameters across the entire study population. This pattern is inconsistent with a normal distribution and suggests that virtually all children in this cohort are experiencing some degree of nutritional constraint. Such findings are characteristic of populations facing widespread poverty, food insecurity, inadequate water and sanitation infrastructure, high infectious disease burden, or systemic barriers to healthcare access.

The comparative severity of height-for-age deficits relative to weight-for-age suggests that the primary nutritional insult is chronic rather than acute. This differentiation has important implications for intervention strategies. While acute malnutrition can often be addressed through short-term therapeutic or supplementary feeding programs, chronic malnutrition requires sustained, multisectoral interventions addressing underlying determinants such as household food security, maternal nutrition and education, infant and young child feeding practices, water and sanitation, and access to preventive and curative health services.

Several limitations should be acknowledged. The cross-sectional design precludes assessment of individual growth trajectories and limits causal inference regarding observed associations. The non-uniform age distribution, while adequate for stratified analysis, may introduce age-related sampling bias. Additionally, the study population may not be representative of the broader population if recruitment occurred through health facilities, potentially selecting for children with greater health-seeking behaviour or more severe illness. Data on potential confounders such as household socioeconomic status, maternal education and nutritional status, feeding practices, infectious disease burden, and access to healthcare were not available and may partially explain observed patterns.

Despite these limitations, the findings carry significant public health implications. The high prevalence of malnutrition, particularly stunting, signals an urgent need for comprehensive nutritional interventions targeting the first 1000 days of life. Evidence-based strategies should include promotion of optimal infant and young child feeding practices, micronutrient supplementation, management of acute malnutrition through community-based therapeutic care, growth monitoring and promotion, and integration of nutrition interventions within maternal and child health platforms [22]. A systematic review demonstrated that multisectoral nutrition interventions, combining health, water and sanitation (WASH), agriculture, social protection, and behaviour change communication, represent the most effective strategy for accelerating stunting reduction [13]. Given the lack of observed catch-up growth, preventive strategies targeting pregnancy and early infancy should be prioritized over solely rehabilitative approaches.

Furthermore, the dual burden of stunting and wasting necessitates integrated management protocols capable of addressing both chronic and acute malnutrition simultaneously. The age-specific vulnerability observed in the 12–24 month period underscores the importance of targeted interventions during the complementary feeding period, including counselling on appropriate complementary feeding, provision of nutrient-dense supplementary foods, and intensified growth monitoring. Recent meta-analyses indicate that integration of WASH and nutrition interventions yields significant improvements in height-for-age and weight-for-age z-scores [13], while social protection programs, particularly cash transfers combined with behaviour change communication, produce modest but significant reductions in stunting prevalence [13,23].

Conclusion

This study demonstrates a severe burden of malnutrition among children aged 12–60 months, characterized predominantly by chronic linear growth failure and compounded by acute wasting. The absence of catch-up growth across age groups and the concentration of severe deficits in the critical 12–24 month period highlight the urgent need for early, sustained, and multisectoral nutritional interventions. Gender disparities, with males disproportionately affected, warrant further investigation and may necessitate targeted approaches. Addressing this crisis requires not only immediate therapeutic interventions but also long-term investments in food security, maternal and child health, water and sanitation, and health systems strengthening to ensure sustainable improvements in child nutrition and development.

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